

perature, which was 98° F. on admission, remained at that point for over ten hours, when it first began to rise, never exceeding, however, 99.5° F.; and the pulse, full and strong, ranging from 78 to 88 per minute. There was also a case of fracture of the base of the skull, admitted last spring, in which at the autopsy was found a rupture in the stomach, with diffuse peritonitis, yet, through the four days before death the pulse had been about 90, and the temperature never above 99.5° F. Of course, in this last case the concomitant injury to the brain may have affected both pulse and temperature, yet it seems undeniable that too much reliance should not be placed on these as an index in cases of possible peritonitis, especially by hospital residents, but that more pains should be taken to make an accurate physical examination and to acquire the *tactus eruditus*.

REFERENCES.

1. Welch. *Pepper's System of Practical Medicine*, vol. II.
2. Lebert's tables, *ibid.*
3. Greenough and Joslin. *Gastric Ulcer at the Massachusetts General Hospital*. *THE AMERICAN JOURNAL OF THE MEDICAL SCIENCES*, August, 1899, pp. 170, 181.
4. Brinton. Quoted in *Reynolds' System of Medicine*, Philadelphia, 1893, vol. II. p. 891.
5. Rasmussen. Quoted in *Osler's Practice of Medicine*, New York, 1898, p. 478.
6. Chambers, Thomas K. *Digestion and Its Derangements*, London, 1856.
7. *Reynolds' System of Medicine*, loc. cit., p. 901.
8. *Ibid.*, p. 905, foot-note.
9. Abercrombie. *Diseases of the Stomach and Intestinal Canal*. Quoted in *Dunglison's edition of the Cyclopædia of Practical Medicine*, Philadelphia, 1858, vol. II. p. 304.
10. Cruikshank. *Anatomy of the Absorbent Vessels*, p. 122. Quoted in *Good's Study of Medicine*, Philadelphia, 1825, vol. II. p. 253.
11. Mayo Robson. *Surgical Treatment of Chronic Ulcer of the Stomach*, *Transactions of the American Surgical Association*, 1901.
12. Osler. *Principles and Practice of Medicine*, New York, 1893, p. 479.
13. *Loc. cit.*
14. Einhorn. Quoted by Mayo Robson, loc. cit.
15. Jaksch. Quoted in *Reynolds' System of Medicine*, loc. cit.
16. *Reynolds*, loc. cit.
17. *Ibid.*, p. 896.
18. *Ibid.*, p. 897.
19. Bidwell. *Operations in Gastric Ulcer*. *THE AMERICAN JOURNAL OF THE MEDICAL SCIENCES*, September, 1899, p. 252.

MALARIA: A SUMMARY OF RECENT PROGRESS IN THE KNOWLEDGE OF ITS ETIOLOGY AND PROPHYLAXIS.

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THIS disease, from its far-reaching effects, the most important we meet in tropical practice, is not limited by any geographical boundaries, but appears in all or nearly all parts of the globe.

In the temperate and far northern countries it is usually mild in character, and by far the greatest number of these cases are those of benign quartan or tertian infection.

It is only in tropical or subtropical countries that we see the ravages of this disease in its malignant and pernicious forms.

It undermines the health of millions of native inhabitants, stands in the way of European or American colonization, invalids the greater majority of those on the sick list of our army and navy, and is responsible, either primarily or secondarily, for a larger death-rate than any known disease of these latitudes.

HISTORY. It has been known and described for several thousand years; 100 n. c., Varro, a Roman physician, stated that it was produced by inhaling or swallowing a small animal which grew in the marshes.

Since that time, and until very recently, it has been regarded as a place disease, of typical miasmatic origin.

The first stride toward our present knowledge of the disease was made in 1880, when Laveran discovered in the blood of malarious patients the plasmodium which bears his name; that this organism is the cause of malaria was quickly verified by careful experiments made all over the world.

Later, in 1885, Golgi described the life-cycle of the organism in man, and pointed out its relationship to the periodicity of the febrile attacks.

In the *Lancet*, November 13, 1897, MacCallum, of Baltimore, described the function of the flagellum (microgamete).

In the following year, 1898, Major Ross, of the Indian Medical Service, a pupil of Manson, who, for several years past, had been at work upon the latter's theory of the rôle played by the mosquito in malaria, was able to announce the life-cycle of the parasite in a certain species of mosquito, the *Anopheles claviger*.

Since then the work of Celli and others in Italy has substantially emphasized the value of these investigations; it is now a certain and generally accepted fact, that malaria is produced by the bite of an infected mosquito of the genus *Anopheles*.

THE MALARIAL PARASITE. In zoölogy the plasmodium of Laveran is classed among the Protozoa, of the order of Sporozoa, and is closely allied to the suborder of Coccidia.

They consist of true cellular elements, protoplasm, nucleus, and nucleolus; they are possessed of amoeboid movement, and multiply by sporulation.

They are true parasites, and live at the expense of the red corpuscles.

Their life-history is divided into two cycles: one in the blood of their human host, which is asexual, and the other in the body of the mosquito, which is sexual. Judging from clinical observations, it is possible that there is a third state of their existence, a latent state within the human organism. If not, how can we explain the malarial manifestations which occur in those who have suffered from the disease, but from whose blood the parasite has been absent for months?

Celli recognizes but three distinct species of the malarial organism, the benign quartan and tertian, and the malignant tertian, or *Æstivo-autumnal*, of the Italians; Manson, on the other hand, describes five, which he classifies as follows:

Benign	$\left\{ \begin{array}{l} \text{Quartan} \\ \text{Tertian} \end{array} \right\}$	do not form crescents.
Malignant	$\left\{ \begin{array}{l} \text{Quotidian—pigmented} \\ \text{Quotidian—unpigmented} \\ \text{Tertian} \end{array} \right\}$	form crescents.

All these as a class have certain characteristics in common; beginning with the time they enter the red corpuscles and grow and live at the latter's expense.

At first the pigment is scattered through the protoplasm, the latter becomes agitated, the pigment arranges itself in the centre, the protoplasm arranges itself in stellate form about the centre, each filament containing a new nucleus, fission begins, the wall of the now destroyed red corpuscle is ruptured, sporulation is complete, the spores escape into the serum, and a new era commences.

Now and then you will see a large spherical parasite escape from a red corpuscle, some of which in a short time become violently agitated, finally throwing out flagellæ, others more granular in appearance remain spherical. The former are the microgametocytes, the flagellæ they throw out the microgametes, or spermoids; the latter are the macrogametes, or ovules, which later, in the stomach of the mosquito, become fecundated by the microgametes, or spermoids, thus continuing the life of the parasite in its extra-corporeal host.

Going into the specialization of the various forms of the parasite, we find that all of them observe this general procedure, differing only in detail.

Quoting Golgi, first taking the benign quartan, we find it to have the following characteristics.

1. It completes its asexual life-cycle in three days (seventy-two hours).
2. It invades nearly the whole red corpuscle, but does not enlarge or discolor it, even when it has almost entirely filled the red corpuscle.
3. The amœboid movement is rather sluggish; the form does not change much while under observation. The contours of the parasite are readily distinguished from the rest of the red corpuscle.
4. The pigment consists of coarse granules, having feeble movements.
5. Toward the end of apyrexia the pigment collects in the centre, and fission or formation of the amœbulæ begins. These are from six, twelve, to fourteen in number; frequently, when the pigment is in the centre, the amœbulæ are arranged around it in a daisy-like form.

The principal characteristics of the benign tertian are—

1. It completes its asexual life-cycle in two days (forty-eight hours).

2. It invades the whole of the red corpuscle, which becomes large and pale. Frequently it is rather difficult to differentiate the contour of the parasite from the edge of the red corpuscle which surrounds it, because of the extreme paleness of that cell. The loss of color of the red corpuscle takes place while the parasite is still small.

3. The amoeboid movement is very active, the changes in form of the parasite are quite apparent, and, while watching it, pseudopodia can be seen to be rapidly protruded and retracted.

4. The pigment consists of fine granules, which move actively.

5. Toward the end of apyrexia, the pigment tends to collect in the centre, and multiplication begins.

The number of amoebuke is usually greater than of the quartan, consisting of from twelve to twenty.

THE MALIGNANT PARASITE. These are very much smaller than the benign parasites, and for this reason, and to the fact that their pigment is much finer, they are much harder to distinguish.

At first they display very active amoeboid movement, but quickly quiet down, and appear as minute bright rings, frequently several in number in the red corpuscles; later in the disease it may be a difficult matter to find even these in the blood from a pricked finger or ear, and even more difficult to find the parasite in its later stages of development; it being necessary to get aspirated blood from the spleen for diagnostic purposes.

We also find in the blood of patients suffering from malignant malarin, crenated, warped, dark-colored corpuscles known as the "brassy bodies;" these are produced by the rapidly necrotic action of the parasite upon the red cell.

The most characteristic feature is the presence of crescents, which are only produced by malarial parasites of malignant type, and are, therefore, absolutely diagnostic. They do not appear in the blood during the early days of the disease, but usually only after the lapse of a week or more. After all traces of fever and the small parasites have disappeared, these crescents persist in the blood, sometimes for two or three weeks, and are usually associated with cachexia.

Some of these crescents develop in the following manner: first the crescent becomes an ovoid, with the pigment scattered through the mass; this in turn becomes more or less rounded, or spherical, then the pigment forms a ring about the centre, then finally approaches the periphery, the whole parasite becomes violently agitated, throwing out flagellae, which have a wave-like motion, many of which break away, and we have the microgamete, or spermoid.

Others simply advance as far as the rounded or spherical formation; these are the macrogametes, or ovules.

The parasite of malignant quotidian malaria is very small, and consists of two varieties, pigmented and unpigmented, and develop much in the usual way; they occupy when mature about one-third or one-fifth of the red corpuscles, and sporulate in twenty-four hours, giving rise to six or eight minute spores.

Those of malignant tertian resemble in many respects the parasite of benign tertian, although much smaller, occupying about one-half to two-thirds of the red corpuscle; at the end of two days (forty-eight hours) they sporulate, in number about eight to twelve. The distinguishing features of the malignant parasites are the formation of crescents, and the small size of the parasites.

LIFE-CYCLE IN THE MOSQUITO. In the stomach or middle intestine of the mosquito, at a temperature of 86° F., the microgametocyte will throw out the microgamete, or spermoid, within the first twelve hours; numbers of these wriggle toward one of the macrogametes, or ovules, which upon their approach becomes violently agitated; finally one of the spermoids effects a successful entrance, and fecundation is completed.

These fertilized bodies, known as zygotes, assume various shapes, usually that of an elongated ovoid; they now penetrate the epithelial cells of the middle intestine; this, as a rule, takes about forty hours.

By a process of direct division, multiplication of the species takes place, and the zygote becomes greatly enlarged, and projects into the general body cavity of the mosquito. When this process is completed, taking about seven or eight days, the sac ruptures, discharging into the general body cavity, a large number, about ten thousand fusiform bodies, known as sporozoites.

These, by means of the lacunar circulation, find their way to the salivary glands of the mosquito, where numbers of them collect, and are injected into the blood of man through the insect's proboscis. Here they at once enter the red corpuscles, and complete the life-cycle we have already described.

THE GENUS ANOPHELES. As this is the only mosquito capable, by its bite, of producing malaria in man, a description of this genus alone is necessary here.

There are four varieties that are able to do this, viz.: the *Anopheles claviger*, the *Anopheles superpictus*, the *Anopheles pseudopictus*, and the *Anopheles bifurcatus*; the first and last varieties are abundant in all malarious localities, the two others are comparatively rare.

The distinguishing points of the adults of this genus are the buccal appendages and the wings, and the position they assume when at rest.

From the head projects a long proboscis and two palpi, the latter being of the same length as the proboscis in both the male and female.

Upon the wings of the *Anopheles claviger* are four black spots arranged in the form of a capital T.

The *Anopheles superpictus* has four black spots arranged in line along the anterior or external edge of its wings, with intervening spots of yellow.

On the wings of the *Anopheles pseudopictus* the black spots are not distinctly marked, while the yellow spots are the same as in the former variety.

The *Anopheles bifurcatus* has no black spots upon its wings.

HABITAT. Mosquitoes live and thrive in low, moist localities, marsh lands, and the low lands covered with underbrush adjoining damp and dark woods, caves, stalls, etc., form their resting-place by day, whence they issue forth in the early evening, and inflict themselves upon man and animals.

As well as an aerial existence, mosquitoes have one in water; that is, the females deposit their eggs upon the surface of the water, where they develop first into larvæ, then into nymphæ, and, finally, the complete aerial insect is set forth.

This process involves from twenty-four to thirty-two days. The eggs of the *Anopheles claviger*, about forty to one hundred in number, are deposited upon the surface of the water in the form of a ribbon-like band, those of the *Anopheles bifurcatus* in a stellate formation; the waters preferred are stagnant, or semistagnant and clear; slow running ditches and canals, meadows, and rice fields are favorite places.

In about three days the larvæ are hatched; these have small heads and a short breathing-tube, and lie parallel to and just beneath the surface of the water, the breathing-tube and a portion of the head protruding above it. They feed in this position, and it is only late in the larval stage that they descend to the bottom for food, and this is done with great difficulty.

COMPARISON OF ANOPHELES AND CULEX.

<i>Anopheles.</i>	<i>Culex.</i>
Selection of water upon which to lay eggs: Clear, quiet, slow running streams.	Selection of water upon which to lay eggs: Artificial pools, receptacles in which water is left standing, grassy streams.
Larvæ: Head small and breathing-tube short. Do not descend to bottom until late in larval stage.	Larvæ: Head large and breathing-tube long. Feed on the bottom, ascending to the surface to breathe.
Larvæ lie just below and parallel to the surface, with breathing-tube and portion of head protruding above it.	Larvæ, while breathing, assume a position of 45° to the surface, breathing-tube protruding.
Adult mosquito:	Adult mosquito:
Palpi of both male and female the same length as the proboscis.	Palpi of female much shorter than the proboscis.
Certain arrangements of spots upon the wings.	No spots upon the wings.
When clinging to horizontal surfaces, the body is almost at right angles to the surface.	When clinging to horizontal surfaces, the body is parallel to the surface.
Vertical surfaces, body at an angle of about 35°.	Vertical surfaces, body parallel.

Malarial infection does not extend far in any direction from given foci, being limited in horizontal, oblique, and vertical directions; this is readily explained by the life of the mosquito.

I cite the following conclusions reached by Celli:

1. The hours during which the malarial germs are most plentiful in the air are those of evening, sunset, and night.

2. They generally rise from limited foci, and are diffused to a limited distance in the horizontal, oblique, and vertical directions.

3. The winds, properly called, do not generally transport them; they tend rather to diminish their number in the atmosphere.

4. Woods, instead of filtering them, may be foci of malarial infection. These axioms are thoroughly in accordance with the theory that the malarial germ is cultivated, transported, and inoculated by the agency of mosquitoes, which—

1. By day lie hidden and sheltered, while they come out to bite man in the evening and at night.

2. They do not wander far from the place where they are born, and especially they fly a little distance from the ground.

3. When the wind blows they do not, as a rule, come out of their hiding-places.

4. Shady and damp woods and trees in general are the nests of mosquitoes. The mosquito, besides being the source, is consequently also the carrier of malarial infection.

PROPHYLAXIS. With the foregoing facts in view, it is obvious that two courses of action present themselves: first the destruction of the mosquito, and, second, the prevention of infection spreading to non-infected mosquitoes; both of these being of extreme importance, not only to the individual or to the community, but to the State as well.

For as the efficiency of a body of troops in the field is directly proportionate to the health of the command, so is the prosperity and happiness of a State dependent upon the health of its inhabitants.

Therefore, from an economic standpoint, as well as from that of the public health, the State should make every effort to free itself from this most persistent and dangerous pest.

What applies to the State applies with even greater force to the community, for the municipality being so much closer to the individual can, by a process of education, and the passage of proper laws, and a rigid enforcement of them, practically destroy the mosquitoes, bringing health and prosperity where formerly quite the reverse was the case. Witness the city of Havana, Cuba, under the able administration of Major Gorgas, Medical Corps, United States Army, Chief Sanitary Officer, and upon a smaller scale the town of Winchester, Virginia, under the wise and progressive administration of its Mayor, Mr. R. T. Barton.

The part of the individual grows more important as the population grows more scattered, and in the smaller towns and isolated places of residence, it will be the work of the individual that will have to be depended upon for results; but in the larger towns and cities much may be accomplished by the intelligent co-operation of the individual with the proper authorities.

DUTIES OF THE STATE. The State, through the channels of its Board of Health, or a body with similar authority, should publish a health bulletin, or a mosquito bulletin, setting forth in a plain, concise manner the relation mosquitoes bear to disease, and also the economic side of the question, showing the relative rise in value of real estate, and the increase in productiveness of lands, which by proper drainage, etc., can be reclaimed, and made not only productive but habitable, thereby producing a great advantage to the individual, as well as to the community at large, and indirectly increasing the wealth and prosperity of the State. Copies of these bulletins should be sent to all local Boards of Health and Boards of Trade, and active co-operation urged and solicited; where extensive swamp lands are a menace to a community and State, the State should render financial help in the reclaiming of such lands.

Copies of these bulletins, with printed instructions as to the best and most improved methods of destroying the mosquito and its breeding-places, should also be sent to all State institutions, with orders to those in charge, that every precaution should be observed for the destruction of mosquitoes and their breeding-places, and inspections made from time to time, by competent inspectors, to see that the orders have been intelligently carried out.

DUTIES OF THE MUNICIPALITY. Similar bulletins should be published by all local Boards of Health, and the individuals of the community thoroughly posted as to the necessity and the methods to be employed for the destruction of the mosquito; also the necessity of protecting all cases of malaria from the bite of mosquitoes, so that non-infected insects will not become infected, thereby spreading the disease.

The following sanitary measures should be adopted and put in force:

1. All hollows within the city limits, and for a mile surrounding it, should be filled in and graded.
2. Marsh lands within the same territory should be properly drained, and, where practicable, filled in.
3. Ponds and streams that cannot be drained or filled in should have their surfaces covered with petroleum, which should be renewed every twenty-one days.
4. Where for any reason this is impossible, fish should be introduced, so that they may feed upon the larvæ.

5. All receptacles holding water should be made mosquito-proof, or where this is impossible the surface covered with petroleum. If this water be drawn, by means of a faucet, from the bottom of the cask or tank, and not dipped out, it will not be unfitted for drinking or washing purposes.

6. Old cans and pans exposed so that they might collect rain-water should be carefully covered.

7. Householders should be advised to thoroughly screen their houses.

8. Thoroughly screened isolation wards should be provided in the hospitals.

9. All cases of malarial fever should be reported to the Board of Health, the same as other infectious and contagious diseases.

10. Where the patient cannot be properly isolated at home, he should be removed to the hospital.

11. The sick room should be thoroughly screened, completely isolating it from the other portions of the house, as well as from the outside.

12. The mosquitoes in the other rooms should be carefully destroyed.

13. When the plasmodium has disappeared from the blood, the patient should be removed to another room, and the mosquitoes in the sick room destroyed by fumigation.

14. Cesspools should have their surfaces covered with petroleum at least once a week.

DUTIES OF THE INDIVIDUAL. He should make himself thoroughly acquainted with the mosquito question, and do everything in his power to aid the authorities in their efforts to destroy them and to protect himself and family from infection.

He should thoroughly screen his house, fill in and grade all hollows on his property, see that all receptacles in which water is allowed to collect and stand are mosquito-proof, or that the water surfaces are covered with petroleum.

If living in the tropics, or in a malarious locality, he and his family should wear warm underclothing, woollens preferred; they should remain indoors as far as possible after nightfall, or if compelled to go out, to protect exposed parts by netting or by the use of such drugs as are known to repel the mosquitoes. Tonic doses of quinine or arsenic are of great value to those habitually exposed to infection.

METHODS FOR DESTROYING MOSQUITOES. This subject has been given considerable attention by investigators all over the world, and various substances have been suggested for use in or upon waters infested by larvæ, as well as for the destruction of adult mosquitoes.

Among the substances suggested as larvicides are the aniline dyes, permanganate of potassium, and petroleum; the latter has been proven to be the only practicable substance of the many named, and is very effective.

The grade of oil selected for the purpose should not be too heavy or it will not spread properly over the surface, nor should it be of such quality as to evaporate quickly; the "fuel oil" of the Standard Oil Company seems to give the most satisfactory results.

An ounce of oil to every fifteen square feet of surface should be used.

Where, for any reason, oil cannot be used, small fish, such as minnows or sun-fish, should be introduced, as these feed upon the larvæ.

In the destruction of the adult mosquito, rooms should be carefully sealed, and such insecticides as sulphur, pyrethrum powder, or formalin used.

Major Gorgas, in Havana, found that pyrethrum powder proved the most satisfactory agent, as it was less offensive to the household, did not destroy or injure fabrics, and was very effective.

One pound of the powder to every 1000 cubic feet of air space should be used; as this does not entirely kill all the mosquitoes, but at times only stupefies them, causing them to fall to the floor, at the end of three hours the room should be opened, and the mosquitoes swept up from the floor and burned.

Drugs, which when applied to exposed surfaces, such as the face, neck, and hands, sometimes prove useful; the best of these are the oils of citronella, lavender, eucalyptus, and pennyroyal; camphor-water is also valuable.

THE THEORY OF CROSS EDUCATION AS APPLIED TO THE AUDITORY APPARATUS.

SOME EXPERIMENTAL STUDIES.

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As long ago as 1836 the sympathetic relation of one ear with the other was recognized by Kramer, and since then varied physiological and pathological phenomena have directed the attention of careful observers to the apparent relation in functioning power exercised by one ear, upon the opposite side. As directly evident that such a phenomena exists, one has but to place a vibrating tuning-fork before one ear, and in the majority of instances the acuity of hearing in the opposite ear for a different sound, such as that of a watch, will be somewhat augmented.

In the so-called sclerotic or catarrhal otitis media, in which a trophic element undoubtedly plays an essential part, and in cases in which the hearing has been reduced in one ear to contact for the watch, a transient auditory stimulation may be produced by the sound-waves from a vibrating body, such as a Cii tuning-fork when placed near the